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NSF Graduate Teaching Fellows in K-12 Education at the University of Maine

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Final Report for Period: 11/1999 - 10/2003

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Principal Investigator: Brawley, Susan H.

Award ID: 9979673

Organization: University of Maine

Title:

NSF Graduate Teaching Fellows in K-12 Education at the University of Maine

Project Participants

Senior Personnel

Name: Brawley, Susan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Norton, Stephen

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Cole, Barbara J.

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Vayda, Michael

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Hunter, Susan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Cobb, Robert

Worked for more than 160 Hours: No

Contribution to Project:

Name: Dill, James

Worked for more than 160 Hours: No

Contribution to Project:

Name: Halteman, William

Worked for more than 160 Hours: No

Contribution to Project:

Name: Hess, Thomas

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Jacobson, George

Worked for more than 160 Hours: No

Contribution to Project:

Name: Jellison, Jody

Worked for more than 160 Hours: No
Contribution to Project:

Name: Harris, Walter

Worked for more than 160 Hours: Yes
Contribution to Project:

Project evaluation supervisor

Name: Singer, John

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Cashon, Robert

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hopper, Cathy

Worked for more than 160 Hours: Yes
Contribution to Project:

Post-doc

Graduate Student

Name: Calder, Beth

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Gordon, Richard

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Daly, Julia

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Hayhurst, Susan

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Spender, Jonathan

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Gillman, Barbara

Worked for more than 160 Hours: Yes
Contribution to Project:

Name: Thomas, Shelly

Worked for more than 160 Hours: Yes

Contribution to Project:**Name:** Smith, Peter**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Purtell, Regina**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Campbell, Steven**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Good, Mary**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Kanan, Marsha**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Kirn, Sarah**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Borden, Melissa**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Pierce, Mary**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Schilling, Jonathan**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Lage, Christopher**Worked for more than 160 Hours:** Yes**Contribution to Project:****Name:** Simpson, Anne**Worked for more than 160 Hours:** Yes**Contribution to Project:****Undergraduate Student****Name:** Morse, Sarah**Worked for more than 160 Hours:** Yes

Contribution to Project:

Name: Phelan, Peter

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Perry, Ethan

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Lynch, Nicholas

Worked for more than 160 Hours: Yes

Contribution to Project:

Name: Bell, Thomas

Worked for more than 160 Hours: Yes

Contribution to Project:

Technician, Programmer

Other Participant

Research Experience for Undergraduates

Organizational Partners

Old Town Schools

Orono-Veazie Schools

Indian Island School

Union 90 Schools

Sunkhaze Meadows National Wildlife Refug

We celebrated the Centennial of the National Wildlife Refuge; the largest public event Sunkhaze Meadows has had (400 students and parents across the district were there). We are beginning to create species list for the refuge and carry out various types of monitoring exercises for them.

Other Collaborators or Contacts

None.

Activities and Findings

Research and Education Activities: (See PDF version submitted by PI at the end of the report)

Major Research & Education Activities of the Grant

The outreach aim of this NSF GK-12 grant was to support teacher and K-12 student attainment of the goals of the Maine Learning Results, which contains ambitious and specific performance indicators for four grade bands (K-2, 3-5, 6-8, 9-12) in Science & Technology. Our outreach into K-12 classrooms was in physical science, earth science, environmental science, biology, chemistry, physics, mathematics, and integrated science classes over 4 school districts in central Maine. Most Fellows worked in grades 3-11, but in specific instances, where recommended by the curriculum coordinator, we sometimes participated in classes at grades 2 and 12. The ability to support a variety of disciplines was possible because we accepted applications from students across the University of Maine who had degree programs in any area of science, technology, mathematics, and engineering, choosing the best candidates each year from this wide pool. Our project supported four undergraduate NSF GK-12 Fellows and 27 different graduate (M.S., Ph.D. students) GK-12 Fellows over academic years 2000-01, 2001-02, and 2002-03. One of these undergraduate Fellows was supported for two years; three graduate Fellows were supported for two years. Fellows typically worked weekly with the same 80-100 students. We served 22-24 Cooperating Teachers each year while making occasional visits to other teachers' classrooms in schools where the Cooperating Teachers worked. The schools served (14 schools) range from small town to rural schools. Maine has an unusually strong local schools' tradition, therefore, the curriculum at a given grade in one district was always different from the curriculum in that grade in another district. This local control also imposes major economic limitations on learning in science and technology in Maine, because each town's schools have to purchase equipment etc. rather than sharing pools of expensive equipment. Thus, major benefits of our NSF GK-12 program include the shared pool of equipment (microscopes, thermal cyclers, etc.) we provided to students and teachers across districts, in addition to the expertise and role modeling of the Fellows as young scientists and engineers.

Inquiry-based field trips to Maine bogs, forests, and the intertidal zone were a major activity of students in our program. For example, students determined the size-classes of herbivorous snails and determined the species diversity of algae in several zones at Schoodic Point (Acadia National Park). In a study begun in Sunhaze Meadows' Wildlife Refuge (Milford, ME) in 2002-03, students surveyed aquatic insects, quantified winter animals by tracks in snow, and analyzed atmospheric deposition via snow chemistry. Eleven classes (G3-11) collaborated to make a 3D topographic map of the Sunhaze watershed. The Sunhaze Meadows' projects were displayed as part of a NSF GK-12 led celebration of the National Wildlife's Centennial in March (2003); classes that had not been able to visit Sunhaze did conservation/environmental history projects. Over 300 visitors came to the poster displays, where students talked about their projects. Teachers reported that they took great pride in this event and that for all concerned, it was great to feel part of a larger project (i.e., across district cooperation). We hope that exercises such as these and our equipment pool will open a different model for the educational process in some areas.

Students have carried out experiments beginning as early as grade 3 under Fellows' direction in a variety of fields. This involves hypothesis testing, figuring out proper controls, understanding replication etc. One of the popular and successful ones at younger grades is based on the topic of 'What do plants need to live and grow?' At higher grades in biology, Fellows have done forensic science exercises; in these, students also develop substantial technical skills during DNA isolation, gel loading, and so forth. In chemistry classes, inquiry based exercises are typically built around use of UV/VIS spectroscopy, including analyzing caffeine content in soft drinks. Both chemistry and earth science classes conducted seasonal studies of natural uptake and decay of radioactive isotopes in conifer needles. Food science Fellows integrated activities in microbiology, nutrition, and natural pigment studies. A major focus of the project was microscope use in support of understanding cell structure and function and the diversity of life; these studies spanned all grades and many types of classes. In a substantial part of Fellow outreach in Grade 7 in 2002-03, activities made use of the State of Maine's Laptop Initiative (i.e., every 7th grader was loaned a laptop) for mathematical and modeling exercises.

Findings:

Major Findings

Objective 1: to increase cooperation between science faculties and K-12 educators. Result: dramatic increase in contacts both ways; teachers (100% response) indicate that they can confidently contact science faculty for help in future. In addition to the listed University of Maine directing and participating science and math faculty, 16 other faculty provide exercises/lectures for the week-long science camp over the 3 years of the project.

Objective 2: to enhance student learning at K-12 in SMET subjects, especially in the local context of the Learning Results. Result: It is too early to use the Maine Educational Assessment test (grades 4, 8, 11) to measure gains but we hope these may show improvements in schools in which we've had substantial participation within the next few years (our first attempt to analyze these will be based upon MEAs given in 2003-04). Teachers (n=22) in Y3 said that their students always (68%) or almost always (32%) looked forward to Fellows' scheduled days in the classroom. Several teachers in one district reported on their Y3 surveys that parents had begun to ask for children to be placed the following year in classes where teachers were participating in the NSF GK-12 Fellows' program. The staff at the Center for Research & Evaluation (UMaine College of Education) observed each Fellow's teaching in Y1 and Y2 as part of their evaluation efforts. Their evaluation in Y1 consisted largely of subjective evaluation such as:

'All Fellows appeared to have benefited from this program. The immense enthusiasm and excitement in each classroom was evidenced by students' attention and focus on the Fellow, their questions and suggestions and their smiles and laughter. Students related to the graduate fellows not so much as teachers, but as 'scientists'. Overall, students stayed on-task and focused. They were clearly engaged in lessons as evidenced by their questions, suggestions, and participation in activities. When listening to students talk to each other, nearly all conversations were about the experiment or topic of the class. Both boys and girls asked questions and provided suggestions throughout each class (Year End Report for PI/Co-PIs, CRE, August 2001, Classroom Observations)'. Teachers have made similar comments each year of the program on their year-end surveys. A consistent increase in use of scientific terminology by K-12 students, which continues when the Fellow isn't there, is often mentioned as a benefit by teachers.

Objective 3: to improve the communication and teaching skills of Fellows while supporting their degree studies and research. Results:

In Y2 and Y3, teachers (n= 46) provided the following mean responses to identical questions on year-end surveys:

1. Were Fellows prepared for their lessons? (1- 5 scale; 1=always prepared, 5=never prepared). Mean response: 1.3
2. Did Fellows communicate with students at the appropriate level? (1-5 scale; 1=always, 5=never). Mean response: 1.7

Fellows generally considered the opportunity to be role models to younger students, to influence K-12 science education, and to receive an excellent stipend in support of their graduate studies to be the key benefits of the program. Typical comments on Y3 surveys follow from Fellows:

'A great benefit to any developing professional that greatly compliments course work and research.' (Comment 1)

'The program provided a good opportunity to practice teaching and communication skills. Also the money was a big help.' (Comment 2)

'Easily the best program I have been involved with at UMaine.' (Comment 3).

In Y3, we asked Fellows if they had been university TAs to comment on the relative merits of that experience versus being NSF GK-12 Fellows as preparation for being a professor. Eight of the 11 Fellows had been TAs and 7 of these Fellows said the NSF GK-12 experience was better preparation for university teaching. The following comments were typical (p. 30, CRE report, Y3 Evaluation for PI/Co-PIs):

'Being a Fellow has been a very valuable experience as a preparation to be a professor. As a TA, I was always provided with the laboratories the students would be doing etc. and there was very little lecturing to be done. After being a Fellow, I believe that I would have an easier time lecturing and developing laboratories for my students. It also helped me to improve my communication skills and ability to explain complex concepts in a more simplified manner.' (Sample comment 1)

'Yes, this is by far a better way to improve skills. TAs have little to do with lesson development, pacing, or order of presentation.' (Sample comment 2)

'Yes, the NSF experience is much better. It focuses on teaching to a roomful of students with varied abilities while being a TA is more of a 'canned delivery'.' (Sample comment 3).

Fellows were asked the following questions in Y1 and Y3. The mean response over these two years is also provided:

1. What has been the impact of the NSF GK-12 outreach on your thesis work? (1-5 scale with 1=strongly negative and 5=strongly positive). Y1=2.2; Y3=3.4 (mean=2.8)
2. Would you recommend the NSF GK-12 fellowship to a peer? (1-5 scale, 1=definitely not, 5=definitely yes). Y1=4.3, Y3=4.4 (mean=4.4).

Major professors were asked to comment on their advisee's progress to degree and communication skills, as affected by the NSF GK-12 Fellowship, with the following identical questions in Y2 and Y3:

1. As reflected in research or course work, how has your advisee's oral communication skills been affected by the NSF GK-12 fellowship? (1-5 scale; 3=no change, 5=much better). Mean over two years: 4.1.
2. As reflected in research or course work, how has your advisee's written communication skills been affected by the NSF GK-12 fellowship? (1-5 scale; 3=no change, 5=much better). Mean over two years: 3.6

3. Would you want another of your advisees to hold a NSF GK-12 Fellowship? (1-5 scale, 1=definitely yes, 5=definitely not). Mean over two years: 1.4

4. How has the NSF GK-12 fellowship affected your advisee's progress toward the degree? (1-5 scale, 1=much slower, 5=much faster). Mean over two years: 2.6.

Advisors reflected that although there was slower progress toward the degree than if the advisee had been supported on a research assistantship, it was worth it for at least a year. They cited increased confidence, improved communication skills, better time management capabilities, and broadened scientific interests and abilities to communicate science to a broad audience of individuals as major benefits to their advisees' professional development.

During the 3 year grant, two Fellows (one in Y2 and one in Y3) were asked to resign early in the fellowship year due to failure to meet expectations for outreach and course work. Ten of 12 Fellows in Y1 have now completed their degrees; 6 of 12 in Y2 are complete; 3 of 12 in Y3 are complete. This includes 10 completed M.S. degrees, 4 completed B.S. degrees, and 2 completed Ph.D.s. Most of our Fellows were appointed in Y2 or Y3 of their graduate careers, so many former Fellows will complete Ph.D.s this year or next year (we allow Fellows to hold the fellowship for a maximum of 2 years). Current professions of Fellows are these (numbers of Fellows in parentheses): K-12 science teacher (2), medical student (3), M.S. student (4), Ph.D. student (12), university researcher (e.g., postdoc) (3), professor (1), government researcher (1), industry researcher or representative (2), environmental non-profit teaching/research (3).

Objective 4: To provide professional development opportunities in SMET disciplines to K-12 teachers.

In a survey, the following response was obtained from an identical question asked in Y2 and Y3:

1. Did (Teachers) benefit from the Fellow's participation? (1-5 scale; 1=Definitely, 5=No benefit). Mean response over Y2 and Y3 (n=46): 1.8.

Teachers strongly prefer a year-long relationship with a Fellow, even if the frequency is one visit each week. Half of our teachers report on surveys that they have learned enough from their Fellows and Science Camp lessons to be able to teach some to much of the new information/activities that Fellows bring to their classes, if the appropriate equipment could be loaned to them. Over the project, 16 teachers participated as co-authors or first authors on posters/talks given at professional SMET meetings with their Fellow. These meetings included the Ecological Society of America, the Society of Conservation Biologists, American Chemical Society, European Phycological Congress, Institute of Food Technologists, Ocean Sciences, American Geophysical Union, Geological Society of Canada, and Integrated Pest Management. Teachers found the opportunity to attend professional meetings to be particularly novel and interesting for them. Typical survey comments follow (CRE report to PI/Co-PIs, July 2003, p. 6):

'These opportunities have given me the chance to travel to new places, meet new people, and grow as a professional in many ways. I've gained new contacts, gotten free software, and units for my classes. It's also very interesting to study 'cutting edge' research.' (Comment 1).

'I thought it was of great value to attend the IPS meeting with [fellow]. I not only got to learn more about his work, but had an opportunity to be able to learn a little about many different topics. I especially enjoyed the poster sessions where I could learn about my particular interests.' (Comment 2).

'This is an excellent opportunity to spread the word about this program. I also found that I could look at what scientists from around the world were doing. This was fascinating!' (Comment 3).

We also sent 3 teachers and 3 fellows overseas to Japan and Kenya on international research experiences in the summer of 2002. The Teacher and Fellow in Japan studied harmful algal blooms at the University of Tokyo and the 2 teachers and 2 fellows in Kenya worked with A Rocha Kenya in a UN Biosphere project doing bird-banding. All did local educational outreach and produced materials being used in our continuing NSF GK-12 program.

In summary, our major conclusions are:

1. The program provides a model for more regional cooperation among districts in Maine in delivering SMET subjects,
2. Fellows' oral communication and teaching skills are improved by the NSF GK-12 fellowship (there is a small increase in written communication skills). This experience is considered better training for being a University professor than a T.A. by most Fellows,
3. It is important to have a program coordinator to assist the PI/Co-PIs,
4. A week of Science Camp (science activities and planning time for Teachers/Fellows) is adequate and important for 'bonding',

5. Long pedagogical training for Fellows is not necessary when they are picked well (we have a rigorous application procedure including essays, transcripts, 3 letters of recommendation, and a 30 minute interview for the last cut with a panel of SMET faculty and participating K-12 teachers)--we do one day of pedagogy,
6. K-12 teachers and our directing faculty became true colleagues---that makes everything run well,
7. K-12 teachers greatly benefit from the novel experience of participating in professional meetings, both by content gains and confidence gains,
8. K-12 students are capable of much more than we generally anticipate they can do (e.g, inquiry based work),
9. The NSF GK-12 program is most successful when Fellows work in a sustained way throughout the year with a small number of Teachers (2-3) and students (80-100). However, such a program can be difficult to develop as a sustainable one, because not enough students are reached on a state-wide basis (our renewal is a hybrid of our original model and shorter contacts with a greatly expanded student/teacher population).

Training and Development:

All Fellows report a great sense of satisfaction and felt they benefited from preparing material for diverse ages of learners. They were chosen on the basis of their excellent communication skills as well as excellent grades and research/teaching promise; however, they report improvements in their communication skills and a sense of satisfaction of being able to communicate science to learners of all levels.

Fellows report learning even better time management skills. Most felt this project had a negative impact on their research but that they got it under control after a few months. Even at this stage, all were very enthusiastic and said they'd recommend the program to a peer graduate student.

Teachers have learned a tremendous amount of science, how to teach science in an experimental way, and what facilities and personnel are available to them at the University of Maine. Prior to this program, there was little contact between science faculty and local schools. We really work as a team now.

Summary comments on Training and development are in the major findings statement above.

Outreach Activities:

This entire project is 'outreach' for faculty and Fellows. See the above statements for detail.

Journal Publications

B. Calder, M. Bagley, S. H. Brawley, "National Science Foundation Graduate Teaching Fellows promote food science education in K-12 schools in Maine", *Journal of Food Science Education*, p. , vol. , (2003). Accepted

Books or Other One-time Publications

Web/Internet Site

URL(s):

<http://www.umaine.edu/NSFGK-12/>

Description:

This site explains our activities and goals in text and photographs; we plan to update it at least every 4 months. The next update, which will include information on our newly appointed Y3 Fellows will be up by August 2002. The Fellows' and Teachers' pages give personal insights from each Fellow and a selection of our Cooperating Teachers on their personal career goals and what the NSF GK-12 program has meant to them.

Other Specific Products

Product Type:**Presentations at scientific meetings****Product Description:**

Abstracts from scientific meetings are sometimes published in journals of scientific societies, but are more often published in program abstracts for attendees and placed on the society's website for the public. I have listed all presentations (to date) on the NSF GK-12 program proper presented by Fellows and Cooperating Teachers from May 2001 through April 2002. Each Fellow also presented a research talk or poster (in cases where only one presentation by the Fellow was allowed, s/he presented only their research). All Fellows and Teachers report being mobbed at these presentations; many have exchanged activity write-ups with persons they spoke to at their posters.

Campbell, S. P., S. L. Thomas, R. Purtell & S. Hayhurst. 2001. Scientists as educators: NSF Graduate Fellows in K-12 Education at the University of Maine. 15th annual meeting of the Society for Conservation Biology, Hilo, Hawaii. (poster).

Campbell, S.P. 2001. NSF Graduate Fellows in K-12 Education at the University of Maine: A Program Overview. Symposium: Graduate Students Conduct K-12 Outreach: The NSF Graduate Teaching Fellows in K-12 Education Program. Ecological Society of America (86th annual meeting, Madison, WI).

Daly, J. F., P. Smith, J. Spender & S. Norton. 2001. Studying the local hydrologic system at the K-12 level (poster). Geological Association of Canada meeting, St. John's, Canada.

Good, M., E. Perry, R. Boone & S. Eaton. 2002. Integrating university-level science research into the primary, middle, and secondary grades. (poster). Northeast Geological Society of America meeting, Abstracts, p. A-32.

Hayhurst, S. & A. Jordan. 2001. Just say no to backbones: Invertebrate zoology as a hands-on tool for biology education at the primary school level (poster). 9th International Congress on Invertebrate Reproduction, Grahamstown, South Africa.

Gordon, R., A. Masters, & M. Doing. 2001. The use of algae as a teaching tool in elementary education. J. Phycol. 37 (3S):19 (poster). Annual meeting of the Phycological Society of America, Estes Park, CO

Sharing Information:

Publicly available abstracts; have given rise to a lot of interaction with meeting participants.

Product Type:**Physical collection (samples, etc.)****Product Description:**

Aquatic insects of Sunhaze Meadows National Wildlife Refuge

Sharing Information:

Will continue to be used and added to in our program; then placed in permanent refuge collection and listed there.

Product Type:**Teaching aids****Product Description:**

Lessons in food science and in ecology

Sharing Information:

They are advertised on our website and most are available there. Directions are provided for ordering our ecology CD (comparisons of temperate and tropical terrestrial forest ecosystems based upon Maine and Kenya work in our program)

Contributions**Contributions within Discipline:**

Please see major findings file.

Contributions to Other Disciplines:

We believe we may be making a contribution to a larger-scale model for SMET education across districts in Maine.

Contributions to Human Resource Development:

These data are provided in the major findings box.

Contributions to Resources for Research and Education:

We acquired pH meters, microscopes, thermal cyclers, balances, microcentrifuges, etc. for use in K-12 schools where none of these resources existed. This is a major impact of this project.

Contributions Beyond Science and Engineering:

Please see major findings file.

Categories for which nothing is reported:

Any Book